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SOLID BOWL HELICAL CONVEYOR CENTRIFUGE COMPRISING AN ADJUSTABLE OUTLET FOR SOLIDS

[0001] The invention relates to a solid bowl helical conveyor centrifuge according to the preamble of Claim 1.

[0002] From German Patent Document DE 43 20 265 A1, a solid bowl helical conveyor centrifuge is known which is provided with a weir on the liquid outlet side which has a passage to which an orifice plate is assigned which, during the rotation of the drum, stands still relative to the latter and which, in turn, is axially displaceable by way of a threaded bush. By means of the rotation of the threaded bush, the distance between the weir and the orifice plate can be changed. The resulting change of the discharge cross-section causes a change of the liquid level in the centrifugal drum, so that a continuous adjustment of this liquid level is permitted by the displacement of the orifice plate. However, an adjustment of the discharge of the solids cannot take place.

[0003] From European Patent Document EP 0 747 127 B1, it is known to arrange a particularly radially adjustable flow regulating element between worm channels in the conical area of the worm. In this case, a relatively long adjusting path has to be bridged in order to implement a change of the outlet cross-section for the solids.

[0004] In contrast, German Patent Document DE 41 19 003 A1, in turn, shows a type of adjustable disk in the transition between the cone and the cylindrical area of the drum and the worm. The adjustment takes place through the worm. The function is that of a baffle plate which also influences the liquid level in the drum.

[0005] From European Patent EP 0 565 268 A1, it is known to provide worm channels only in the cylindrical part of a worm body and to place a type of retaining disk at the axial end of the worm body. Among other things, it is a problem that a worm construction has to be selected which basically differs from conventional worm constructions.

[0006] From European Patent Document EP 0 798 045 A1, it is known to assign a throughput control device to the discharge opening for the solids. This device is arranged at the exterior side of the drum shell, which is to permit an easy visual inspection of the throughput control device. However, the implementation of the adjustability of the throughput control device at the exterior side of the drum rotating during the operation is relatively problematic because it

is not close to the center but has to be implemented on a relatively large diameter where the peripheral speed is relatively high.

[0007] With respect to the prior art, Japanese Patent Documents JP 2002 153771A and JP 2003 153772A a well as German Patent Documents DE 41 19 033 A1 and DE 39 21 327 A1 are also mentioned.

[0008] A centrifuge according to the invention is known from German Patent Document DE 1 823 269. In this document, the non-existent adjustability of the adjusting cone as well as the adjusting device of Figure 2 by way of a torsional nut from the outside, which requires very high constructional expenditures and is relatively complicated, are disadvantages of some embodiments. An automatic adjusting of the adjusting cone against a spring is also disclosed which, however, in practice does not lead to satisfactory results.

[0009] It is a task of the invention to eliminate this problem.

[00010] The invention achieves this task by means of the object of Claim 1.

[00011] Accordingly, at least one or more connecting rod(s) is/are fastened to the adjusting disk which, while the construction is simple, allow an uncomplicated operation or an adjusting of the adjusting disk from the outside.

[00012] The non-rotatable connection of the adjusting disk with the worm or its worm body and the arrangement as an axial extension of the worm as well as the selected method of operation surprisingly permit in a simple manner, for example, "through the worm body" (or possibly through the drum) an adjustability of the cross-section of the at least one (or more) discharge opening(s) for the solids. Furthermore, the worm body may have worm channels in the cylindrical section as well as in the, for example, conically tapering section.

[00013] In the constructively simplest manner, the connecting rods (in the sense of displaceable pressure and tension rods) permit the operating of the adjusting disk without the requirement of implementing an adjusting rotating movement.

[00014] By means of the arrangement "as an extension" of the worm - particularly as an extension of the conical section of the worm - it becomes, in turn, also possible to arrange the adjusting disk and its adjusting unit particularly close to the center. In this case, it is also conceivable to lead the adjusting forces, for example, by means of the connecting rods, close to the center through the drum, although the arrangement in the worm or its drive shaft is particularly advantageous and permits an arrangement which is particularly close to the center.

[00015] By means of the invention, relatively short adjusting paths can also be implemented for changing the outlet cross-section. The adjustment takes place, for example, as a function

of the TS (DS) content (dry substance) of the solids (whose determination is known per se and does not have to be explained here in detail).

[00016] Preferably, the adjusting disk (which, in turn, may preferably be constructed to be "plane" or flat but does not have to be) is axially displaceably arranged in the drum. In this case, it may also be swivellable.

[00017] The adjusting disk is preferably oriented completely perpendicularly or radially with respect to the axis of rotation.

[00018] In a particularly preferable and simple manner, the end of the connecting rod facing away from the adjusting disk is directly or indirectly connected with a rod or a pipe, which centrically penetrates an inlet pipe in the axis of rotation of the solid bowl helical conveyor centrifuge. Here, the connecting rod can be constructed as a part which does not go along in the rotation and can be housed in a particularly uncomplicated manner.

[00019] The axial displaceability can relatively easily be implemented by means of an electromotively operable adjusting or driving unit or a hydraulic or pneumatic device through the worm body, particularly when these act upon the connecting rod which is fastened to the adjusting disk and which penetrates the axial end of the worm body of the worm axially adjoining the distributor. The adjusting unit may also be arranged inside the worm body (for example, an electric motor).

[00020] The adjusting device is preferably arranged as an axial extension of the drum end in a constructively simple and space-saving manner in a discharge chamber which axially adjoins the worm.

[00021] In many applications, the adjusting disk may also have recesses which always permit a defined "minimal passage" of solids. The recesses can be distributed on the outer circumference; however, they may also be constructed in the manner of bores, slots or the like, or, for example, in a segment-type manner. The disk is preferably plane but in various cases may also have a, for example, curved construction.

[00022] The invention is meaningfully supplemented by a computer-controlled control device for controlling the adjusting disk, particularly as a function of the dry-substance content of the solids. The numerical control or the control computer of the machine, which nowadays is often assigned to the centrifuges, can be shared for this purpose. This control can then act upon the adjusting unit.

[00023] Additional advantageous further developments are contained in the subclaims.

[00024] In the following, the invention will be explained by means of embodiments with reference to the drawing.

[00025] Figure 1 is a sectional view of a part of a first solid bowl helical conveyor centrifuge according to the invention;

[00026] Figure 2 is a sectional view of a second solid bowl helical conveyor centrifuge according to the invention analogous to Figure 1;

[00027] Figure 3 is a sectional view of a third solid bowl helical conveyor centrifuge according to the invention analogous to Figure 1;

[00028] Figure 4 is another sectional view of the axial end of the solid bowl helical conveyor centrifuge from Figure 1; and

[00029] Figure 5 is a sectional view of a fourth solid bowl helical conveyor centrifuge according to the invention analogous to Figure 1.

[00030] Figure 1 illustrates a solid bowl helical conveyor centrifuge with a machine housing 1 in which the drum 3 is arranged which has a horizontal axis of rotation. A worm 5 is arranged in the drum 3.

[00031] The drum 3 and the worm 5 each have an essentially cylindrical section 3a, 5a and a tapering section 3b, 5b adjoining it. The worm blade 42 surrounds the cylindrical as well as the tapering area of the worm or of the worm body 29.

[00032] The drum 3 also has another cylindrical section 3c which adjoins the conically tapering section 3b and which defines a discharge chamber 15 whose diameter is smaller than the diameter of the cylindrical section 3a and the diameter in the conical part 3b of the drum 3.

[00033] An axially extending centric inlet pipe 7 is used for feeding the centrifuged material by way of a distributor 9 into the centrifugal chamber 11 between the worm 5 and the drum 3.

[00034] When, for example, a sludgy mash in guided into the centrifuge, particles of solids are deposited on the drum wall. A liquid phase forms farther toward the interior.

[00035] The worm 5 disposed on a bearing 13 rotates at a slightly lower or higher speed than the drum 3 and delivers the centrifuged solids toward the conical section 3b and beyond it to a cylindrical discharge chamber 15 in the second cylindrical area 3c of the drum 3, which cylindrical discharge chamber 15 adjoins the worm in the axial direction, which drum 3, in turn, is provided with at least one discharge opening 17 for the solids leading radially toward the outside from the drum 3.

[00036] In contrast, the liquid flows to the larger drum diameter at the rearward end of the cylindrical section of the drum 3 and is discharged there at overflow openings 19 with an adjustable weir 21.

[00037] An adjusting device is assigned to the at least one discharge opening 17 for the solids,

which adjusting device can be moved such that, by means of it, the cross-section of the discharge opening 17 is more or less cleared.

[00038] In the second cylindrical section 3c of the drum, the adjusting device has an adjusting disk 25 which is arranged as an axial extension of the worm and is axially displaceable there and rotates together with the worm or is non-rotatably arranged relative to the latter.

[00039] In particular, the adjusting disk 25 is aligned perpendicular with respect to the drum axis and can be displaced axially below the discharge opening 17, which changes the available outlet cross-section of the discharge opening 17 for the solids. For implementing the displaceability, its outside diameter is adapted to the inside diameter of the second cylindrical section 3c of the drum.

[00040] At least one or more, particularly three connecting rod(s) 27 is/are fastened to the adjusting disk 25 which are arranged perpendicular to the latter and which penetrate(s) the axial end of the worm body 29 of the worm 5 into a chamber 28 in the interior of the worm body 29, which chamber 28 axially adjoins the distributor 9 but is not connected with it.

[00041] The end of the connecting rod 27 facing away from the adjusting disk 25 is fastened to a ring 31 (here, by means of screw nuts 23), which is disposed by means of a bearing 33 on a rod 35 which, during the operation of the solid bowl helical conveyor centrifuge, does not rotate along with the worm 5 or drum but stands still and which centrically penetrates the inlet pipe 7 in the axis of rotation of the solid bowl helical conveyor centrifuge.

[00042] As a result of the bearing 33, the adjusting disk 25 with the at least one connecting rod 27 can rotate together with the worm 5 during the operation of the centrifuge.

[00043] When the rod 35 is axially displaced (for example, by means of a not illustrated servo motor outside the drum 3) together with it, also the bearing 33, the ring 31, the connecting rod(s) 27 and thereby also the adjusting disk 25 are axially displaced which, in turn, changes the discharge cross-section for the solids.

[00044] According to Figure 1, the inlet pipe does not go along in the rotation. In the case of constructions with an inlet pipe which does go along in the rotation (not shown here), the bearing can also be arranged outside the decanter (rotary transmission).

[00045] According to Figure 1, only a relatively low speed difference has to be mechanically overcome. Since the transition from the stationary rod 35 (connecting rod) to the at least one or more (particularly two or preferably three) connecting rods 27 preferably rotating along with the worm 5 - see Figure 4 - is arranged relatively close to the center, only a relatively low speed difference has to be mechanically overcome.

[00046] Depending on the construction of the decanter, the stationary connecting rod 35 of the

servo motor (not shown) can be guided in the manner of Figure 1 through the feeding pipe 7 or, for example, in the manner of Figure 3, through the worm drive shaft 41 to the non-rotatable ring 31. The connecting rods 27 are preferably arranged on the end situated opposite the drive (particularly of the worm and drum). If the drive were, for example, in Figure 2, arranged to the left of Figure 2 or on the tapering end of the drum, the connecting rods 35 are guided in a particularly surprising - but practical - manner from the opposite end of the drum 3 - thus from the cylindrical end - into this drum. This is reversed in Figure 3.

[00047] Figure 2 differs from Figure 1 by the manner of the operation of the adjusting disk 25.

[00048] According to Figure 2, the ring 31 does not run on a bearing but is used as a piston-type sliding element 39, which can be operated by a fluid, the rod 35 being replaced by a pipe 37 which is used for the feeding and removing of the fluid (for example, a hydraulic fluid such as water) into and out of the pressure chamber 48.

[00049] The evacuation can also take place by way of one or more bores in the worm body 29 (not shown).

[00050] The axial position of the sliding element 39 and thus the position of the adjusting disk 25 depends on the inflowing quantity of the adjusting fluid and on the counteracting solids delivery force acting upon the adjusting disk 25, which delivery force also acts as a restoring force. The sliding element 39 is sealed off with O-rings 43 on the interior wall of the cylindrical section 3a of the worm body and on the pipe 37 and is axially displaceable.

[00051] Figure 5 shows a variant with a swivellable adjusting disk 25, which also implements the required axial mobility or displaceability with respect to the worm end. By means of a shaft 45 or of a hinge, the adjusting disk 25 is swivellably linked to the axial worm end, whereas, in turn, one or more of the connecting rods 27 are linked to the peripheral area of the adjusting disk facing away from the shaft 45. As a result, the cross-section of the solids discharge opening 17 available for the discharge of the solids can also be changed in a simple manner. This hinge is advantageously situated opposite the worm opening at the end of the worm.

[00052] List of Reference Numbers

Solid bowl helical conveyor centrifuge	1
drum	3
worm	5
cylindrical sections	3a, 3c, 5a
tapering sections	3b, 5b
inlet pipe	7
distributor	9
centrifugal chamber	11
bearing	13
discharge chamber	15
discharge opening for solids	17
overflow openings	19
weir	21
screw nuts	23
adjusting disk	25
connecting rod	27
chamber	28
worm body	29
ring	31
bearing	33
rod	35
pipe	37
sliding element	39
worm drive shaft	41
worm blade	42
O-rings	43
shaft	45
pressure chamber	48